 

# Economic analysis of early ripening system for table grapes

Alexandria Sinnett, William Dalton, Kristen M Pitt and Mark O Downey
Department of Primary Industries, Melbourne Victoria 3000 Australia
mark.downey@dpi.vic.gov.au

**Abstract.** High temperatures, rain and high winds (at great intensity at times) have led to scientists and producers exploring options that enable greater control over the effects of weather on primary industries. In this study the suitability of an Italian pergola trellising system (the pergola) for table grapes was assessed on a property in Sunraysia. The study was established in 2009 through Palms Vineyard, the Australian Table Grape Association (ATGA) and Horticulture Australia Limited (HAL). The Victorian Department of Primary Industries (DPI) and Regional Development Victoria (RDV) gathered scientific and production information about this technology from the trial site. The scientific study was the subject of a separate report. In this article, we report on a cost and benefit analysis of installing a pergola on a case study farm. The key message from this analysis is that installing a pergola over a table grape property is worth investigating while there is a price premium for the fruit produced.

**Keywords:** table grapes, new technology, benefit cost analysis.

## Introduction

Table grapes make up a significant proportion of agricultural production in Australia. Within the Sunraysia region, table grapes represent 18% of the gross value of agricultural production (ABS 2008).

According to Table Grapes Australia (2010), table grape production has almost doubled in the past 10 years – from 65,000 tonnes in 1998 to about 120,000 tonnes in 2010. Fresh table grapes are now one of Australia's leading horticultural exports (approximately 45% of grapes produced in Australia are exported). The majority of Australia's table grape production occurs in the semi-arid Sunraysia region of northwest Victoria.

Weather is a significant factor in growing table grapes; the quality of fruit can be severely downgraded as a result of sun, wind or rain damage. Growers have changed trellis design, and included the use of covers and various canopy structures in order to achieve better management of these elements. Some growers in the late 1990s and early 2000s developed structures that were based on wind net enclosures – such structures resulted in more even bud burst (as a function of increased humidity) and better bunch elongation (as a result of less wind at flowering). However, the use of such structures was isolated in Victoria and did not lead to serious consideration of the role of permanent protection in the table grape industry.

A team of scientists within the Department of Primary Industries Future Farming Systems Research Division (FFSR) investigated the application of the 'Italian Trellis Pergola' system under Australian conditions. (This research received funding from Palms Vineyards (Merbein, Vic.), Regional Development Victoria (RDV), Australian Table Grapes Association (ATGA) and Horticulture Australia Limited (HAL)). DPI researchers investigated the temperature, relative humidity, wind speed, soil moisture and plant phenological characteristics with and without an Italian trellis pergola system. This formed the first part of the study (Pitt et al. 2011).

In the second part of the study, which is the focus of this article, the benefits and costs of installing the pergola system on a table grape case study farm were evaluated.

The aim of the economic study was to investigate two different scenarios for a table grape farm in Sunraysia, Victoria. The first involves continuing with the current system. The second scenario involves installing a pergola system on part of the farm, in addition to continuing with current activities.

The key research questions were:

- Is there a net benefit from installing a pergola system over part of a table grape property in the Sunraysia region of Victoria?
- What are the implications for risk and returns?

### Method

The case study method was used for this project as it enables an in-depth analysis of different decisions a farmer can make. The case study method considers the complex combination of human, production, environmental, financial and risk components of a farm business (Makeham and Malcolm 1993). In-depth examination of a small number of farms can offer greater insight on the impacts of changes in the operating environment or system, compared with analysis or use of broad industry data (Crosthwaite et al. 1997; Sterns et al. 1998).

 

The usefulness of case studies and the role they play in farm economics has been well established (see Crosthwaite et al. 1997). The learnings from case study research can be used to test theory (either through adding support to current theory or to challenge accepted wisdoms). Further, findings from case study research can be disseminated to other farmers. Results about possible alternative ways of operating can be presented and explained.

Two farms in the Sunraysia region were investigated. The first had trialled the pergola system as part of the FFSR /RDV/ATGA/HAL/Palms Vineyards research project, on one hectare of land for the table grape variety Crimson Seedless. This farm was used to gather information on costs of the trellis, but was not used as the primary case study as it was a much larger operation than a typical table grape property in Sunraysia. The second farm was chosen as it met the case study criteria for this research which included:

- operating with industry best practices;
- maintaining good records;
- representative of current table grape properties (in terms of size, management practices, water use, and a full-time owner operator); and
- supplying the export market.

The primary case study farm had 19 hectares planted to table grapes. For a complete set of details on the farm and the assumptions used refer to the Appendix.

The two scenarios considered for the case study farm were:

- continue with the current system, which included changing variety on 2 acres (0.8 hectares) every four years; and
- continue with the current system (as described above) with the installation of a pergola over 25% of the farm.

The information provided by the analysis that follows can help the case study farmer judge how to run the farm over the next decade.

The steps taken in this research are outlined in Figure 1.

### *The measures of performance*

For the purposes of the economic analysis, the farm is 'purchased' in year one and 'sold' in year 12. The results, the Net Present Value (NPV) and the return to marginal capital, of the investment are based on a 12-year life of the investment. These measures of performance are explained in more detail below.

*The net present value (NPV)* is one criterion used to judge investments on the farm. The NPV is the sum of all the benefits minus all the costs after they have been converted into their equivalent present values by discounting.

The difference between the present value of benefits and costs is called the NPV.

$$NPV = PV\text{(benefits)} - PV\text{(costs)}$$

Decision makers want investments that provide a NPV greater than zero when the NPV is calculated using a cost of capital or discount rate that represents the return foregone from a realistic alternative investment. Net Present Value analysis allows for the fact that when a resource is allocated to one investment, it is no longer available for use in other investments. The process of discounting captures this effect by deducting the amount that the resource could earn in its best alternative use, or, if the capital is borrowed, deducting the interest cost. Therefore the merit of these two different scenarios are compared with the returns the resources invested could earn if alternatively invested on or off the farm. Access to finance is not considered a limitation in the analysis.

*Return to marginal capital* shows the performance of the extra capital that is added to the business if a pergola system was installed over 25% of the property. This figure can be compared with what the extra capital invested could earn in other uses on or off the farm as part of the farmer's overall investment portfolio. Return to marginal capital is estimated using a partial development budgeting method, where only the extra returns and extra costs resulting from the change to the system and extra capital invested are analysed.

*Risk* associated with each of the different futures for the case study farm over the planning period is incorporated in the analysis by using probability distributions of key variables such as commodity price and water allocations. Information from farmers and researchers was used to develop the probability distributions (see Appendix for more detail).

'Monte Carlo' sampling (Kroese et al. 2011) from these probability distributions for 1,000 'runs' of the 12-year farm plan enables random combinations of grape prices, water allocations and temporary tradeable water prices to occur and probability distributions of the NPV output criteria to be estimated. From this the probability of NPV being above or below critical levels is revealed. These distributions are presented as a probability density function and a cumulative distribution function (CDF). The probability density function shows the range and mean of results. The CDF allows the option that is stochastically dominant to be identified.

That is, plotting CDFs from different scenarios for the same representative farm on the one graph provides a powerful analytical tool for assessing which scenario has the greater business risk and which scenario will make the most efficient use of capital. The scenario that generates a CDF that lies further to the right when plotted on the same axis as an alternative scenario makes more efficient use of that capital. That is, a CDF for one option located to the right of the CDF of another option is said to be a stochastically dominant option. This means that for the same level of risk, the option promises higher return, or, for the same return, lower risk (Hardaker et al. 2004). The first degree stochastically dominant option is preferable (Figure 2) for someone who simply prefers more for no extra risk (i.e. most people).

Risk can be defined in a number of ways. This analysis is primarily concerned with business risk, not financial risk. Business risk refers to the volatility of factors affecting the business such as yields, prices, costs, weather events, disease events, accidents, and so on. Financial risk exists separately to business risk. Financial risk is the risk associated with level of debt and equity of the business, and the debt servicing obligations this entails. The level of gearing (debt to equity) of a business exacerbates business risk. Only business risk is accounted for in the results of this analysis.

### *The costs and benefits of an Italian Pergola system*

The following outlines the extra benefits and costs of installing a pergola trellis system on the case study farm.

The extra benefits will result from:

- Price premiums for grapes grown under the pergola system as a result of:
  - Grapes ripening earlier and being sold into markets with low supply levels compared to grapes that are not grown under the pergola; and
  - Improvements in grape quality due to less wind rub and sunburn, resulting in a grape that is more attractive to the consumer compared with those grapes that are grown outside the pergola.
- A lower crop water requirement as grapes that are grown under the pergola system require 15% less water compared to grapes grown outside the pergola.

The extra costs that are included in the analysis are:

- Capital costs:
  - Initial capital costs such as steel rail strainers, support posts, extender internal posts, cables and wire, plastic covers and concrete (based on installation over existing vines rather than a greenfield site);
  - Ongoing capital costs, occurring every three years for plastic cover replacements.
- Variable costs:
  - Additional variable costs include an increased labour requirement and additional chemical applications.

### *Presenting the results*

The results of the analysis are presented as cumulative distribution functions (CDF) and probability density graphs that depict the probability of earning a range of returns for the following outcomes:

- Net Present Value
- Return to marginal capital invested in changing the farm plan
- Cumulative net cash flow

The average (mean) values and standard deviations of the distributions of outcomes are also presented. The discount rate and return to marginal capital are in real terms.

### *Results*

The results are presented in two parts:

- the first section presents the analysis based on a table grape property that is operating within the current water trading rules; and
- the second section presents the sensitivity of key variables (price of capital and the price premium).

The key assumptions are presented in Table 1, and case study data in Table 2.

### *Results based on current water trading rules*

The results, based on the assumptions in Table 1, suggest that:

- A farm with a pergola system installed over 25% of the property has a 50% chance of generating $1,000,000, in the 12 year period. A farm without a pergola that has a 50% chance of generating $800,000 over the same period.

- Business risk is less for a farm with a pergola system installed compared with a farm without it.
- The return to marginal capital is expected to be 20% real, when the price premium is set at an extra $20 per box of harvested table grapes (currently a bank term deposit could earn at least three to four% real return to capital).
- The mean annual net cash flows for a farm with a pergola installed are higher compared with a farm that does not have a pergola installed. Annual net cash flow falls every three years because of the capital cost of replacing the plastic covering.
- Greater borrowings are required if a pergola is installed on the property. This is offset by higher cash flows resulting from the expected price premium earned from grapes grown under the pergola (Figure 4).

### *Sensitivity analysis*

The sensitivity analysis shows that:

- At a capital cost of more than $200,000 per hectare to install a pergola system, it results in a net cost to the farmer and is not advisable.
- The farmer"on the trial site estimated that the initial capital cost could be as low as $50,000 per hectare. At a capital cost of $50,000 per hectare, the farm system with a pergola is expected to earn approximately $400,000 more real net wealth (over the 12 years) compared with a farm system that does not have a pergola installed.
- If the assumptions listed in Table 1 remain the same, but the price premium is less at say $10 per box (rather than $20 per box), the return to marginal capital is 5% real. At a price premium of $15 per box, the return to marginal capital is 13% real.
- In order for the farm with a pergola to earn a greater net benefit than the farm without a pergola installed, an average or most likely price premium of more than $17 per 10 kilogram box will be required.

## Conclusion

The economic merit of investing in a pergola trellis system over part of a table grape property will depend on:

- the initial capital cost of the pergola (and the ongoing capital cost of the replacement plastic);
- the price premium expected to be received;
- the size of the area covered by the pergola; and
- the size of additional costs to manage the pergola (sprays and more labour).

Finally, it is also important to note that this analysis only looks at the numbers; it does not, and cannot include the qualitative factors (such as management) that are crucial in making a venture like this a success. Growers need to manage the timing of installing and removing covers during the season to achieve optimum results. If the covers are left on too long, vines fruitfulness required for the next season will be reduced. Such issues can result in smaller fruit, eroding the price premium expected and therefore eroding the expected benefits of the system. Thus, the expected return depends very much on the grower's ability to manage increased disease risks and new knowledge about when to open the covers, when to close the covers, when to remove the covers and when to put the covers back on.

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## Appendix

### Water allocations

Given that it is difficult to predict water allocations due to the seasonal nature of resource availability, a number of different estimates for water allocations were used in the model. These allocations were based on historical water allocations for the Murray system. A cumulative distribution function of these historical allocations was developed whereby the probability of different allocations was estimated. These numbers were entered into the software program @Risk™ (http://www.palisade.com/risk/).

For the purposes of this analysis, Low Reliability Water Share (LRWS) has been expressed as a proportion of High Reliability Water Share (HRWS).

### Commodity price

Customs collects export and import data by value and volume was obtained via the Australian Bureau of Statistics (2008). In order to calculate price in the model, value was divided by volume. This is only a guide as the calculated price is an average for all grape varieties and across a whole year. The price the grower receives will be different. However, upon examining these data and adjusting it to current dollar value and subtracting charges it was assessed as a reasonable estimate. These data were then used in a triangular distribution. The mean price generated by this distribution was $26 per 10 kilogram box, which was also the average of the prices the case study farmer received.

For the grapes grown under the pergola a premium was added to the price described above. This price premium was based on a triangular distribution (the lowest possible price premium was $10, the most likely price premium was $20, and the highest possible price premium was $30). The mean price premium used was $20 per 10 kg box of table grapes.

### Variable and fixed costs

Variable costs and fixed costs are based on the growers estimate and data from Kristic (2005). These data were based on the 2002-03 season, it was inflated (by 3% every year) in order to produce 2010 costs.

- Variable costs: $14,127 per hectare
- Overhead costs: $253,255 (total)

The temporary tradeable water price is another uncertain variable in the model. It is assumed that if allocations are below crop water requirement, then water is automatically purchased from the temporary tradeable market in order to maintain production. Estimating the cost of this water is difficult as the price is determined by a number of external factors. Brennan (2004) and Bjornlund (2005) both argue that the price of temporary trade water is strongly correlated with water allocations. However upon examining data from 2008, the price of water varied from $265 per megalitre to $550 per megalitre even when allocations remained unchanged at 43%. This indicates there are other factors that influence the tradeable price including commodity prices, rainfall and allocations. Qureshi et al. (2010) also take account sunk costs in the form of asset fixity and remaining productivity life of crops. For example, a grower with young vines may be likely to pay more for water than a grower with old vines.

Based on current knowledge it was determined amongst the project team and project working group that an average weighted temporary trade water price (weighted for the volume traded in that year) for the last four years would be appropriate, particularly when considering a long-term climate change scenario.

### Initial capital cost of the pergola

The price for capital infrastructure was estimated at $100,000 per hectare. Horticulture Australia Limited (HAL) budgeted for $120,000 per hectare, but actually spent $100,000 per hectare; this was the figure used. Sensitivity analysis has been undertaken to assess the impact different initial capital costs are likely to have on investment return.

It was assumed that the salvage value of the investment at year 12 (when the investment has an expected life of 12 years) would be worth 50% of the initial capital cost if the farm business was sold.

 

***Ongoing capital cost of the pergola***

Every three years the plastic covers on the pergola trellis require replacing. This comes at a cost of $20,000 per hectare (a total cost of $95,000 every three years for an area of 4.75 hectares).

***Extra variable costs***

It was estimated that an extra $10,000 per hectare per year would be required to manage the pergola system – this would cover extra labour and extra chemical sprays. This was estimated from the trial site.

***Benefits of the pergola system***

The main benefit of the pergola system is a price premium. It is expected that under the pergola system grapes will ripen earlier compared to grapes grown outside the pergola system – early market grapes are assumed to attract a price premium. In addition it was expected that under a pergola system there should be less wind rub and sunburn – which should increase quality and also attract a price premium.

It was assumed that under the pergola a premium variety, such as Crimson Seedless, was grown.

Another benefit of the pergola system is water savings. Under the pergola system, a 15% water saving can be achieved resulting in a crop water requirement of 8.30ML/ha compared to 9.77ML/ha for grapes grown outside the pergola.

 

Table 1 Key assumptions

| | **Per unit value** |
|---|---|
| Area under pergola trellis | 25% |
| **Cost** | |
| Initial capital cost of pergola | $100,000 per hectare |
| Cost of replacement plastic | $20,000 per hectare |
| Additional labour costs | $10,000 per hectare per year |
| **Benefit** | |
| Average price of grapes outside the pergola | $26 per 10kg box (mean export price) |
| Price premium | $20 per 10 kg box (mean price premium) |

Table 2 Case study data

| | |
|---|---|
| Farm size | 20 hectares (19 hectares planted) |
| Water share | 9.144 ML/ha |
| Crop water requirement | 9.77 ML/ha |
| Area redeveloped | 2 acres (0.8 ha) every four years<br>Year one 0.8 ha redeveloped and no yield<br>Year two 0.8ha 50% yield<br>Year three 0.8ha 100% yield<br>Year four another 0.8ha redeveloped and no yield on so on |
| Cost of redevelopment | 500 vines per hectare<br>$5.50 per vine<br>Labour cost of $10,000 |
| Average yield across varieties | 1500 ten kilogram boxes per hectare |
| Purchase price of farm and water (walk in/walk out value) | $1,100,000 |

Table 3 Net economic benefit

| | **Future 1 (no pergola)** | **Future 2 (pergola installed on 25%of the property)** |
|---|---|---|
| **Mean NPV (discount rate is 8%)** | $809,593 | $1,019,744 |
| **Standard deviation** | $294,943 | $292,861 |

 

Figure 1 Schematic diagram of methodology used

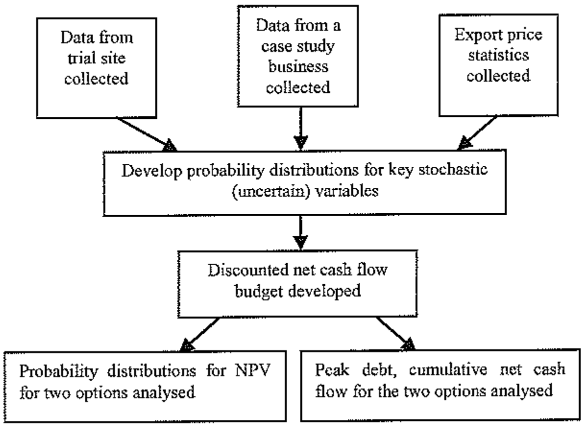


Figure 2 Hypothetical cumulative distribution function for option one which is stochastically dominant over the base case

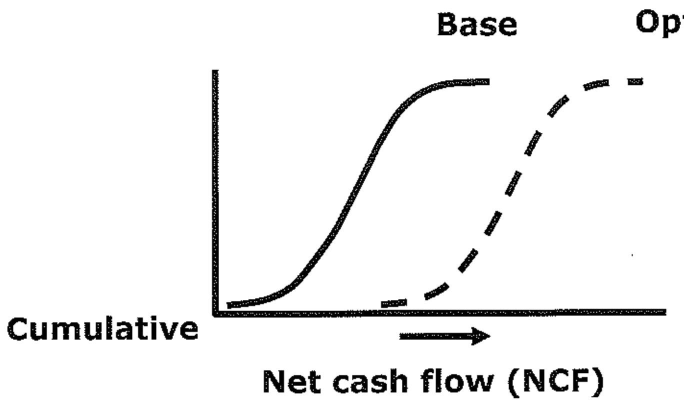

Figure 3 Cumulative distribution function (CDF) of a farm system without a pergola installed on the property and a CDF of a farm system with a pergola system installed on 25% of the property.

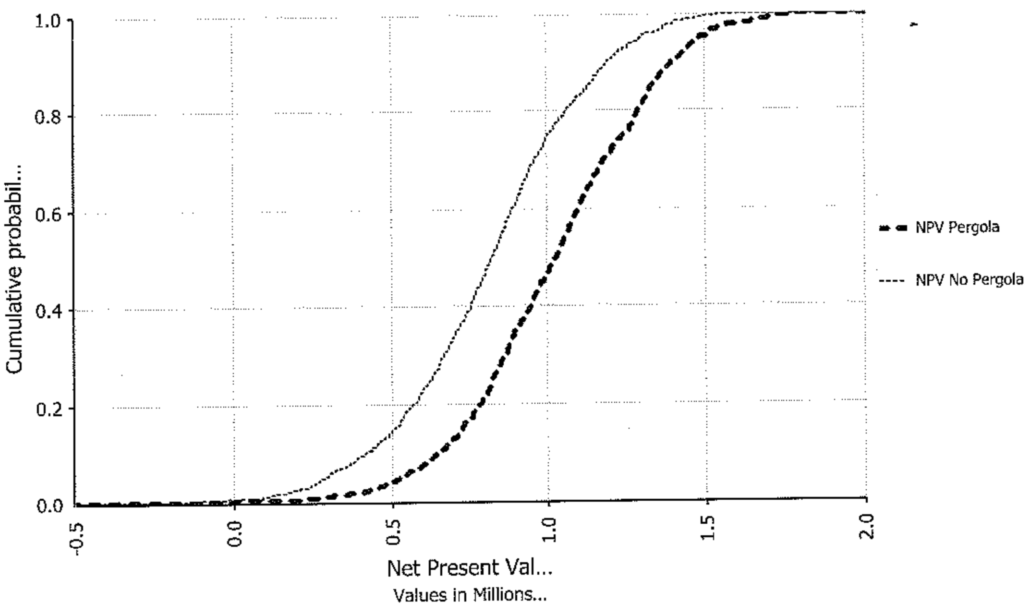


Figure 4 Expected mean annual net cash flows for a farm with a pergola, and expected mean annual net cash flows for a farm without a pergola.